Estimation of Stature on the Basis of Measurements of the Lower Limb

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INTRODUCTION

Forensic anthropology, an applied discipline, is a branch of physical anthropology, which interacts with other disciplines pertaining to the understanding of crime and its investigations. Examination of skeletal remains recovered from a scene of crime, have often been used by the forensic anthropologists to extract relevant information about the victim. One such aspect pertains to reconstruction of living stature from such skeletal remains.

Forensic anthropologists while dealing with skeletal remains have very little choice to use anatomical method for stature reconstruction due to non-availability of complete skeleton from a scene of crime in most of the cases. Thus, they have no choice but to use a relatively less precise method of stature reconstruction, i.e., the mathematical method, which is workable even if a single long bone is available.

To overcome the lack of non-availability of documented skeletal material in India for establishing the norms of stature reconstruction, researchers have followed the technique suggested by Allbrook (1961), where he measured the long limb bone dimensions among living people and formulated multiplication factors and regression formulae for determination of stature. These regression formulae and multiplication factors can be applied to estimate stature of a population from its skeletal remains. Since then multiplication factors and regression equations have been formulated on various living population groups of India to reconstruct stature. These means of stature estimation are reported to be both population and sex specific (Patel et al.1964; Joshi et al., 1964; Kate and Majumdar, 1976; Nath et al., 1990; Nath and Krishnan, 1990; Anand and Nath, 1990; Nath et al., 1991; Nath and Routray, 1996; Nath, 1997; 2005; Kaur and Nath, 1997; Jain and Nath, 1997; 2004; Nath and Kaur, 1998; Nath et. al., 1999; 2005; Sethi and Nath, 2001; Devi and Nath, 2001; Devi and Nath, 2005; Bhavna and Nath, 2005; Tiwary and Nath, 2005; Jain et al., 2006; Rani and Nath, 2006; Bhavna et al., 2006; Rani et al., 2006). All these studies have reported significant difference in the proportions of the limb bone dimensions, due to the environmental and genetic differentiation.

Owing to the genetic and sex variations observed in different population groups in India, an attempt has been made in the present study to compute multiplication factors and regression equations for estimation of stature among male Shia Muslims of Delhi. The Muslims constitute 11.7% of the total population of Delhi (Census of India, 2001). The population of Shia Muslims is less in Delhi as compared to the Sunni Muslims. Shia constitutes less than 50% of the total Muslim population.

MATERIAL AND METHODS

Data for the present study constitutes of 503 male Shia Muslims of Delhi, in the age range of 20 to 40 years. Each subject was measured for the following percutaneous dimensions besides stature, according to standard measurement techniques (Martin and Saller, 1959; Allbrook, 1961) on the left side.

1. Stature (S): It is obtained as the projective distance between the standing surface and the highest point on the head (vertex) when the subject is standing in the standard standing position, using anthropometer rod.

2. Femur Length (FEML): Subject stand erect with the left leg placed slightly ahead of the right one and the foot partly everted to relax the soft tissues. Using the rod compass, measure the distance from the upper most point on the greater trochanter to the lower most point palpable on the lateral femoral condyle.

3. Tibial Length (TIBL): Subject sat with left knee placed in the semi flexed position and the left foot partly everted to relax the soft tissues and render bony landmarks prominent. Using the rod compass, length of tibia from the medial condyle (as it becomes palpable and diverges anteriorly from the articulating femoral condyle) to the tip of the medial malleolus is measured.

4. Fibular Length (FIBL): Subject sat with

left knee placed in the semi flexed position and the left foot partly everted to relax the soft tissue and render bony landmarks prominent. Using the rod compass, the distance between the upper most point palpable on fibular head, (little below the lateral margin of the knee) and the tip of the lateral malleolus is measured.

5. Foot Length (FL): Subject stand erect with left foot twelve inches forward than right foot with whole weight of body falling on left foot. Using the rod compass, measure the distance between acropodian and pternion when the foot is fully stretched.

6. Foot Breadth (FB): It is obtained as a distance between metatarsal tibiale and metatarsal fibulare, using sliding caliper.

Data analysis was done using SPSS/PC package for computation of multiplication factors, correlation and regression equations for reconstruction of stature from the five percutaneous dimensions of the lower extremity besides calculation of mean, S.D. etc.

RESULTS AND DISCUSSION

Table 1 presents the mean values, standard deviation (S.D), and standard error of mean (S.E) for all the five lower extremity measurements and stature among male Shia Muslims of Delhi. Among the five lower extremity measurements foot breadth exhibits the lowest value of standard deviation (0.63) while the highest value is observed for femur length (1.96).

Table 1: Mean and other statistical constants of different body dimensions among male Shia Muslims of Delhi (n = 503)

S.No.	*Body Dimensions*	*Mean (cm)*	*S.D*	*S.E*
1.	Stature (S)	167.66	5.69	0.25
2.	Fibular Length (FIBL)	38.58	1.88	0.08
3.	Tibial Length (TIBL)	36.48	1.91	0.08
4.	Femur Length (FEML)	41.71	1.96	0.09
5.	Foot Length (FL)	24.88	1.61	0.07
6.	Foot Breadth (FB)	10.11	0.63	0.03

Table 2 displays the multiplication factor (M.F) values for five measurements pertaining to lower extremity among male Shia Muslims of Delhi. It is observed that the highest value of M.F is exhibited by foot breadth i.e. 16.62 whereas for the femur length the M.F value is least, (4.02).

Table 3 presents the correlation values (r) of different lower extremity measurements with stature among male Shia Muslims of Delhi. It is observed that tibial length exhibits the overall highest value of correlation (r = 0.765) with stature followed by fibular length and femur length while foot breadth exhibits the least correlation (r = 0.383) with stature.

Table 2: Multiplication factors of different body dimensions for estimation of stature among male Shia Muslims of Delhi

S.No.	*Body Dimensions*	*Multiplication Factor*
1.	Fibular Length (FIBL)	4.35
2.	Tibial Length (TIBL)	4.60
3.	Femur Length (FEML)	4.02
4.	Foot Length (FL)	6.76
5.	Foot Breadth (FB)	16.62

Table 3: Correlation values of different body dimensions with stature among male Shia Muslims of Delhi

S.No.	*Body Dimensions*	*Correlation Value (r)*
1.	Tibial Length (TIBL)	0.765
2.	Fibular Length (FIBL)	0.758
3.	Femur Length (FEML)	0.743
4.	Foot Length (FL)	0.546
5.	Foot Breadth (FB)	0.383

A body dimension which correlates highly with stature, would provide more accurate estimate of stature as compared to the one that has a relatively low correlation with stature.

Table 4 presents the linear regression equations for estimation of stature from five lower extremity measurements for male Shia Muslims of Delhi. These linear regression equations have been formulated on the basis of correlation and listed in descending order of correlation value. Tibial length provides the best estimate of stature as it exhibits the overall highest value of correlation (r = 0.765) and least value of standard error of estimate (SEE = ±3.66). Fibular length however, provides the second best estimate of stature. Foot breadth, which exhibits the highest error of estimate and lowest value of r, should be used only in the absence of the other measurements of the lower limb.

It has been established by the earlier studies that the means of stature reconstruction, i.e. M.F

Table 4: Linear regression equations for estimation of stature from different body dimensions among male Shia Muslims of Delhi

S.No.	*Linear Regression Equations*	*S.E.E*	*Value of 'r'*
1.	S = 84.74 + 2.27 (TIBL)	± 3.67	0.765
2.	S = 79.35 + 2.29 (FIBL)	± 3.71	0.758
3.	S = 77.99 + 2.15 (FEML)	± 3.80	0.743
4.	S = 119.74 + 1.92 (FL)	± 4.77	0.546
5.	S = 132.61 + 3.46 (FB)	± 5.26	0.383

or regression formulae are both population and sex specific and thus it is important to first identify the recovered remains and then relevant measurements should be taken to reconstruct the stature. Though both the methods may be used but regression equations provide greater reliability in estimated stature.

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on the basis of correlation. Tibial length provides the best estimate of stature as it exhibits the overall highest value of correlation

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